# U.S. Environmental Protection Agency

# TENORM

Recent Additions | Contact Us | Print Version Search: EPA Home > Radiation > Programs > TENORM > TENORM Sources

GO

Radiation Home News Information Topics

Visitors'Center Site Map

Programs Home TENORM Home

**TENORM Sources Summary Table** Laws & Regs **About TENORM Working With** Other Orgs. Contact Us **Publications** Links

Common

Questions

# **TENORM Sources**

- Mining and Resource Extraction
- **Energy Products**
- Water and Waste Treatment
- **Products Containing TENORM**

# Mining and Resource Extraction

TENORM may be present in mining wastes. These wastes, most significantly from uranium mining, may be generated in large volumes and stored on land near the mine site. The waste rock and soil has little or no practical use. Uranium mine wastes from mines that closed before about 1975 are of particular concern. In many cases, these mines remain unreclaimed today, with the wastes piled near the mine as it was when the mine closed.

Uranium

Gold and Silver

Fertilizer Production

Rare Earths

**Aluminum** 

**Titanium Ores** 

Copper Waste Rock

Zircon

return to: [top] [previous location]

#### Uranium

The mining of uranium ores by underground, by in-situ leaching, and by surface methods produces large and small amounts of bulk waste material, including excavated top soil, overburden that contains no ore, weakly uranium-enriched waste rock, and subgrade ores, and evaporation pond sludges and scales. These materials typically contain radionuclides of radium, uranium, and thorium.

Materials

Solids

Radiation Level [pCi/q]

low average high

**Uranium Mining Overburden** 

low

Uranium In-Situ Leachate

30

low hundreds

**Evaporation Pond** 

300

3000





### **Programs**

Programs Home

WIPP Oversight

Yucca Mtn. Standards

Mixed Waste

Federal Guidance

Naturally

Occurring Radioactive Materials

Radon

Radionuclides in Water

**SunWise** 

Rad NESHAPs

Regional Programs

MARSSIM

MARLAP

Cleanup: Technologies &

Tools

Risk Assessment

Radiological

Emergency

Response

Clean Materials

Laboratories

return to: [top] [previous location]

#### **Fertilizer Production**

The production of phosphates for fertilizer generates wastes in very large volumes that are stored in huge piles called "stacks" that cover hundreds of acres in Florida and other phosphate-processing states. These radioactive materials contain radium and other radionuclides and create large amounts of radon. EPA and state agencies have regulations controlling these wastes. In addition, the state of Florida has created an independent state research agency charged with investigating ways to minimize adverse environmental impacts of the phosphate industry.

Materials	Radiation Level [pCi/g]		
	low	average	high
Phosphate Ore (Florida)	7	17.3-39.5	6.2-53.5
Phosphogypsum	7.3	11.7-24.5	36.7
Phosphate Fertilizer	0.5	5.7	21



Radiation in TENORM Summary Table

rad-NESHAPs: Subpart R

return to: [top] [previous location]

#### Aluminum

Waste muds created by the extraction of alumina from its ore, bauxite, may contain low levels of radioactivity, usually from uranium, thorium, radium, and their radioactive decay products

Materials	Radiation Level [pCi/g] low average higl		
Ore (Bauxite)	4.4	NA	7.4
Product		0.23	
Production Wastes	NA	3.9-5.6	NA



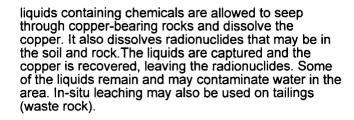
Radiation in TENORM Summary Table

return to: [top] [previous location]

#### **Copper Waste Rock**

Mining and extraction of copper by common surface or underground methods can concentrate or expose uranium, thorium, and radium in waste rock. Another extraction method, known as "in-situ" leaching, can transport uranium and thorium into groundwater or surface water at the site. In this method, rather than removing soil and rock to reach the copper deposit,

2 of 6 10/11/02 3:42 PM



Wastes	Radiation Level [pCi/g]		
	low	average	high
Copper Waste Rock	0.7	12	82.6

info

Radiation in TENORM Summary Table

return to: [top] [previous location]

#### **Gold and Silver**

While few studies have been done on these ores. some western mines produced uranium as a secondary product when extracting precious metals. Pitchblende (a naturally occuring material containing low concentrations of uranium) has been found in the same ores as gold and silver. Waste rock from some of these mines may be radioactive.

return to: [top] [previous location]

#### Rare Earths

Rare earths are a group of elements that have electrical properties that make them useful in electronics and electrical applications. Lanthanides and yttrium are recovered primarily from ores and minerals that naturally contain uranium and thorium. As a result, the waste rock and sludges from the extraction of rare earths also contain these radionuclides.

Materials	Radiation Leve		l [pCi/g]
	low	average	high
Rare Earths(Monazite, Xenotime, Bastnasite)	5.7		3224



Radiation in TENORM Summary Table

return to: [top] [previous location]

#### **Titanium Ores**

Uranium, thorium, and radium commonly occur in titanium ore and monazite occurs in sands from which the titanium is extracted. As a result, the mineral sludges, dusts, and sands from the extraction process may be radioactive.

Radiation Level [pCi/g] low average high		
	8.0	24.5
3.9	19.7	NA
NA	5.7	
3.9	12	45
	3.9 NA	8.0 3.9 19.7 NA 5.7



Radiation in TENORM Summary Table

return to: [top] [previous location]

# **Zircon**

Zircon is naturally radioactive, containing small amounts of uranium, thorium and radium in its crystalline structure. It is also mined from deposits containing other radioactive minerals such as monazite.

Materials	Radi	Radiation Level [pCi/g]		
	low	average	high	
Zircon		68		
Wastes	87		1300	



Radiation in TENORM Summary Table

For more about abandoned mine lands, visit What is EPA Doing About TENORM?

return to: [top] [previous location]

# **Energy Production Wastes**

Coal and Coal Ash
Geothermal Energy Waste Scales
Petroleum (oil and gas)

### **Coal and Coal Ash**

Coal contains trace quantities of the naturally occurring radionuclides of uranium, thorium, and potassium as well as their radioactive decay products. When coal is burned, minerals including most of the radionuclides do not burn and as a result are concentrated in the ash.

Wastes	Radiation Level [pCi/g]		
	low	average	high
Bottom Ash	1.6	3.5-4.6	7.7
Fly Ash	2	5.8	9.7

info

Radiation in TENORM Summary Table

return to: [top] [previous location]

### **Geothermal Energy Waste Scales**

Using geothermal energy, requires drilling deep holes (boreholes) and inserting pipes for pumping high-temperature fluids from the ground. The rocks that contain the high-temperature fluids may also contain minerals, which tend to form a scale inside the pipes and production equipment. If the rocks also contain radionuclides, such as radium, the mineral scale, production sludges, and waste water will contain TENORM.

Wastes	Radiation Level [pCi/g]		
	low	average	high
Geothermal Energy Waste Scales	10	132	254



Radiation in TENORM Summary Table

return to: [top] [previous location]

#### Petroleum (Oil and Gas)

The rocks that contain oil and gas deposits often contain water as well. The water will dissolve minerals and radionuclides, such as radium, that are in the rocks. As a result, radium and its radioactive decay products become concentrated in production wastes. Wastes include: pipe scale that tends to form inside oil and gas production pipes and equipment, large volumes of waste water, and sludges that accumulate in tanks or pits.

Wastes	Radiation Level [pCi/g]		
	low	average	high
Produced Water [pCi/l]	0.1	NA	9,000
Pipe/Tank Scale	<0.2	5 <200	>100,000

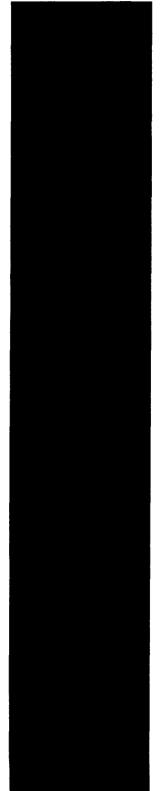


Radiation in TENORM Summary Table

return to: [top] [previous location]

# **Water and Waste Treatment Residues**

5 of 6 10/11/02 3:42 PM



### **Water Treatment**

Since water comes from streams, lakes, reservoirs and aquifers, it contains varying levels of naturally occurring radioactivity derived from surrounding rocks and sediments. Wastes from municipal water treatment plants receiving this water may concentrate some amounts of this radioactivity, even if the treatment systems were not originally designed to remove it.

Wastes	Radiation Level [pC			
	low	average	high	
Treatment Sludge [pCi/l]	1.3	11	11,686	
Treatment Plant Filters		40,000		
Radiation in TENORM Summary Table				

return to: [top] [previous location]

# **Products Containing TENORM**

Some TENORM may be found in certain consumer products. For example, zircon contains minute quantities of uranium and thorium, and is widely used as a glaze for ceramics and metal molds.

The EPA and others working on the problem have identified many sources of TENORM. Identifing sources and determining the potential risks from them remains a major focus of our work.

return to: [top] [previous location]

■ TENORM Summary Table About TENORM Common Questions

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Radiation Home · News · Topics · Information · Programs · Visitors' Center · Site Map

EPA Home | Privacy and Security Notice | Contact Us

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